ChemCam Automated Target Selection Status

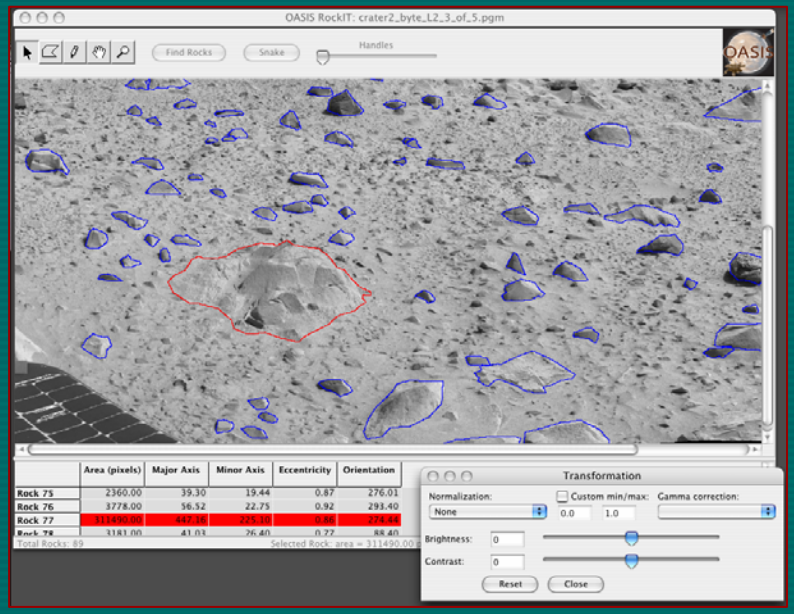
Becky Castano
Ben Bornstein
JPL

Outline

- Testing
  - Legacy
  - Bonneville
  - Selected Site Set

Validation Approach

- Accuracy assessment
  - Data
    - MER HazCam, NavCam and PanCam images
      - Location of rocks marked by hand
  - Prioritization
    - Size
    - Select sample of different albedo/colors
- Resource assessment
  - Determine run time under MER FSW environment



Tool for hand labeling

Blind Sampling vs Automatic Target Selection

- With 10% rock coverage
  - Random (blind) sampling
    - Expected only 1 out of 10 samples will be of a rock
    - On 50% of sols with blind sampling, not a single rock sample will be acquired, other days only 1 out of five samples expected to be of a rock
  - 80% target success rate
    - Expected 8 out of 10 samples will be of a rock
    - Four out of five samples of rocks expected every sol with end-of-day sampling
    - 8X increase in science return over blind sampling
    - 33% increase in return for instrument on traverse sols on mission
      - Average sol samples of rocks increases from 10.5 (10 targeted plus average 1 every other day untargeted) to 14 (10 targeted plus 4 end-of-day)

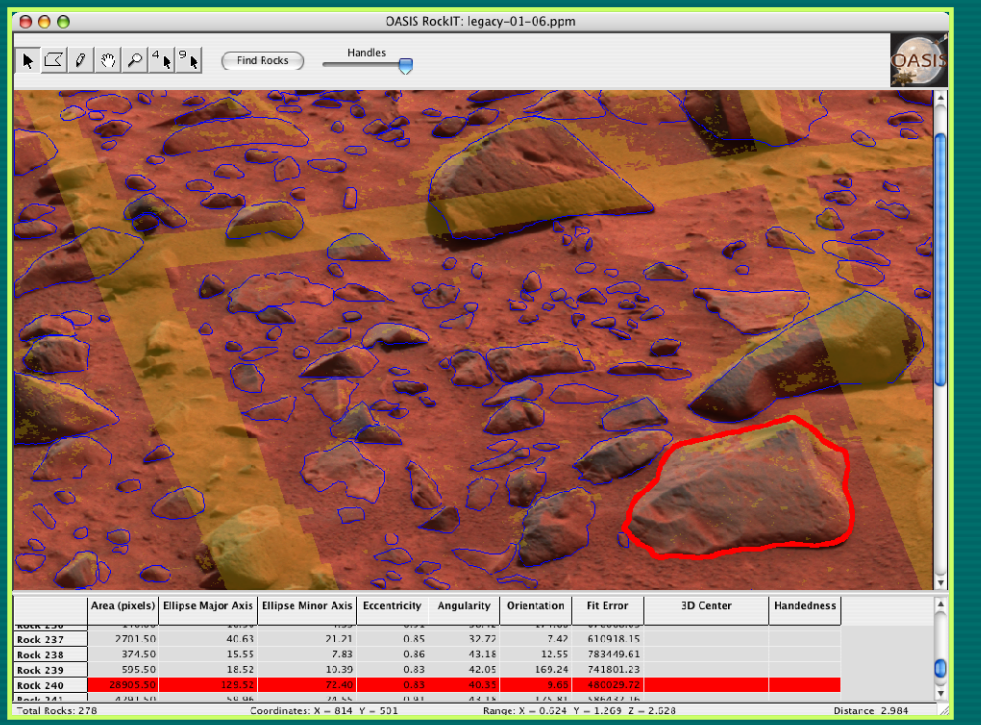
Target Selection Requirements

Target prioritization

1. Rock vs soil (rocks higher priority, ok to occasionally get soil)
   - Goal: 80% rocks
2. Larger rocks higher priority because they can be cored (small rocks ok occassionally)
   - ~10cm
3. Would like some far away and one within the IDD radius such that it could be cored the following sol (IDD box –less than 1m)
4. Other features
   - Diversity of albedos
   - Rocks with layers

Identify Candidate Targets

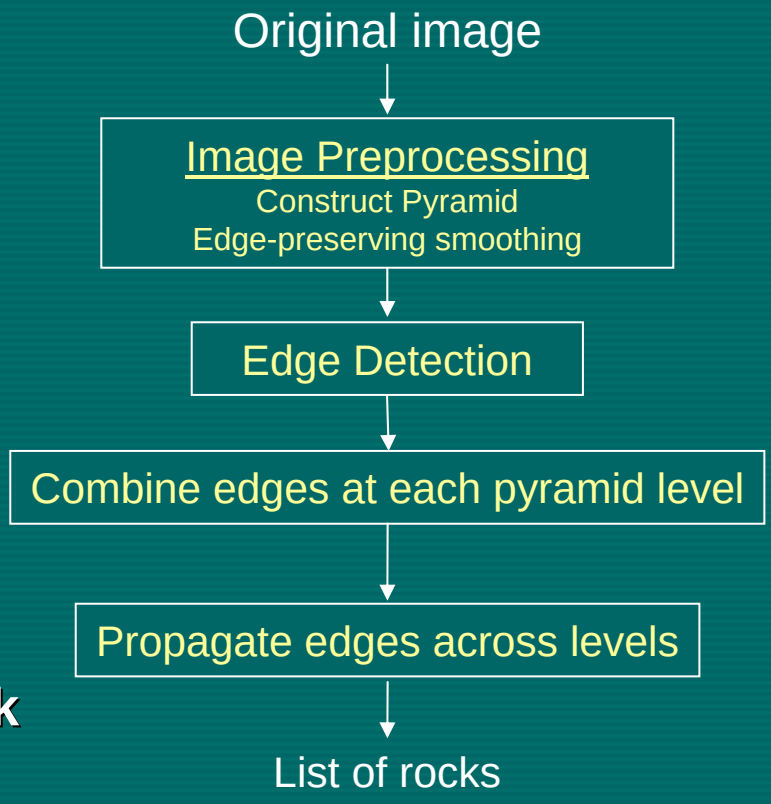
- Locate Rocks
  - Edge-based rock finder
- Select Points on rock
  - Min Area (pixels)
  - Avg Area
  - Max Area
  - Min Perimeter (pixels)
  - Avg Perimeter
  - Max Perimeter



Technical Approach

- **Usage Scenarios**
  - **Identify candidate targets**
    - **Locate rocks**
    - **Select points on rocks**
  - **Identify and prioritize candidate targets**
    - **Locate rocks**
    - **Select points on rocks**
    - **Extract rock properties**
    - **Prioritize points based on rock properties**

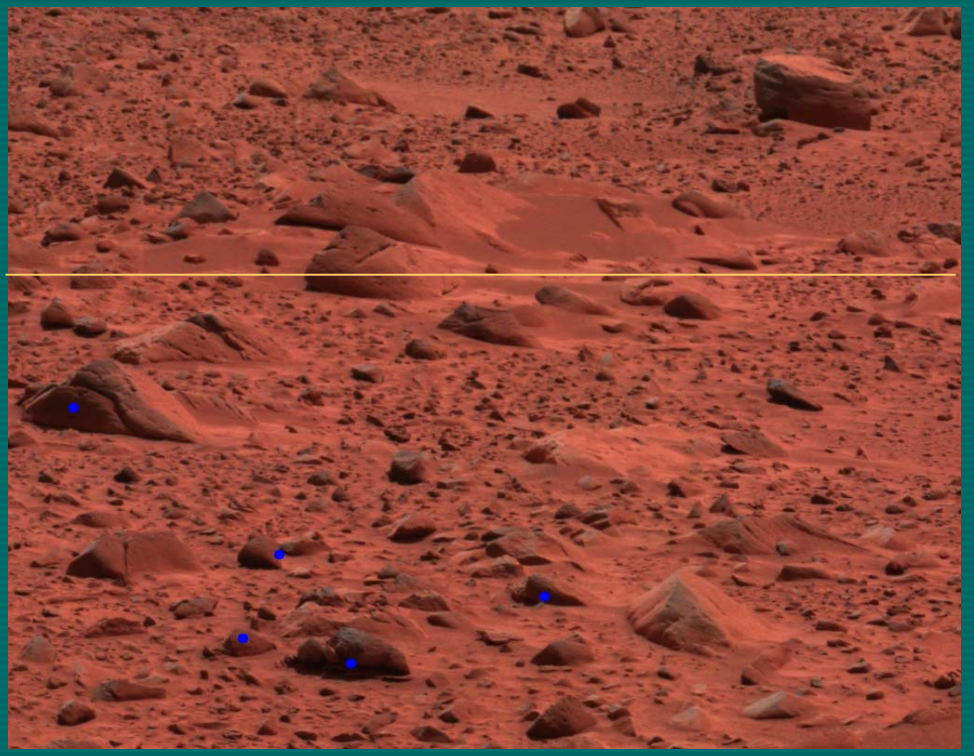
Locate Rocks Algorithm



Legacy Results

- Legacy – 65 images
- Target selection
  - Top 5 targets selected for each image
  - Criteria: max perimeter
- Results:
  - 92% of selected targets are rocks

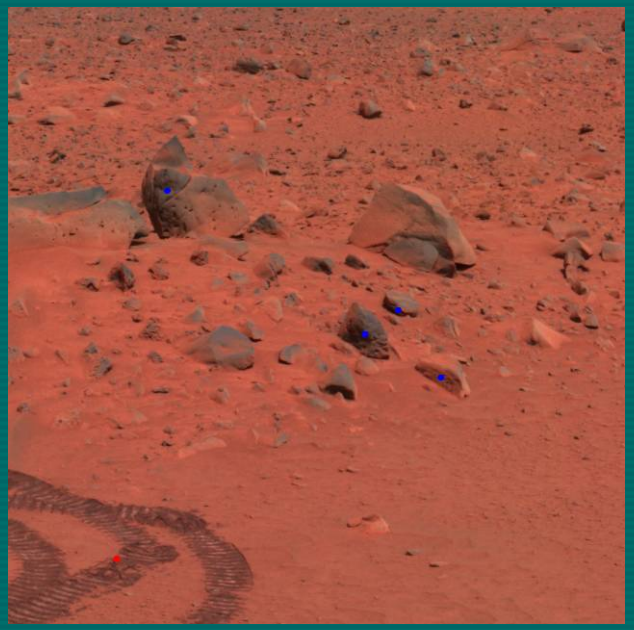
Example Image



Selected targets are shown in blue

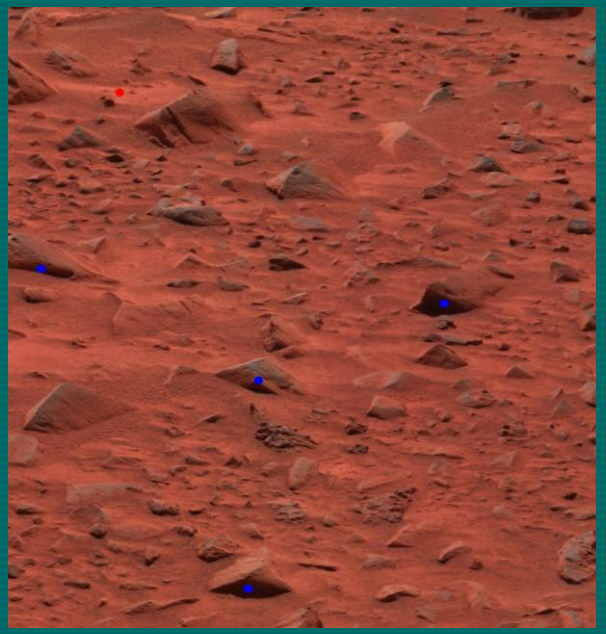
Legacy Target Selection Errors

- 9.8% misses (28 target selections out of 285)

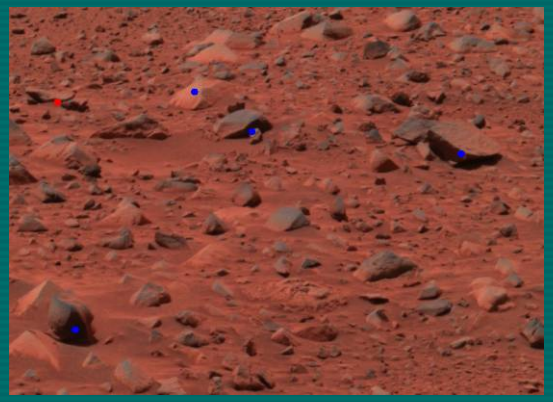


Rover tracks: 16

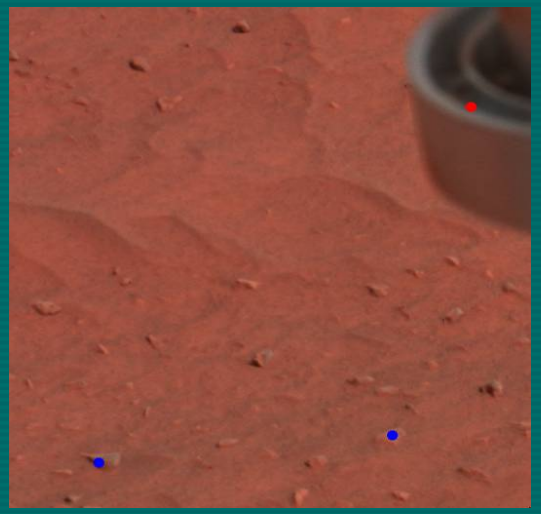
Other miss: 1



Sand patch identifed as a rock: 1



Near miss: 7



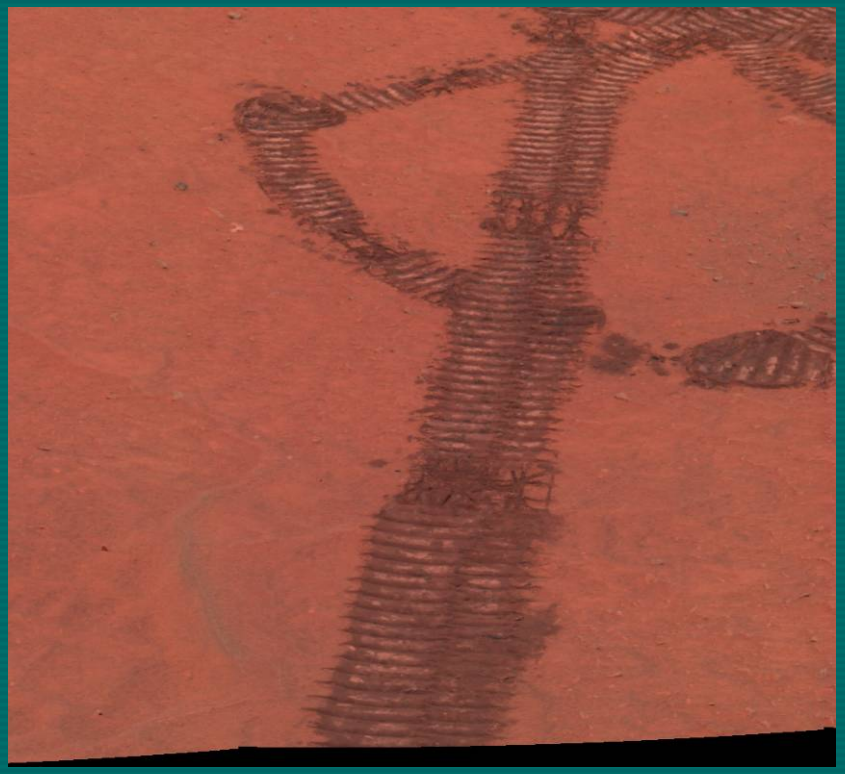
Rover parts: 3

Blue: Correct
Red: Miss

Legacy Images – No Rocks Detected

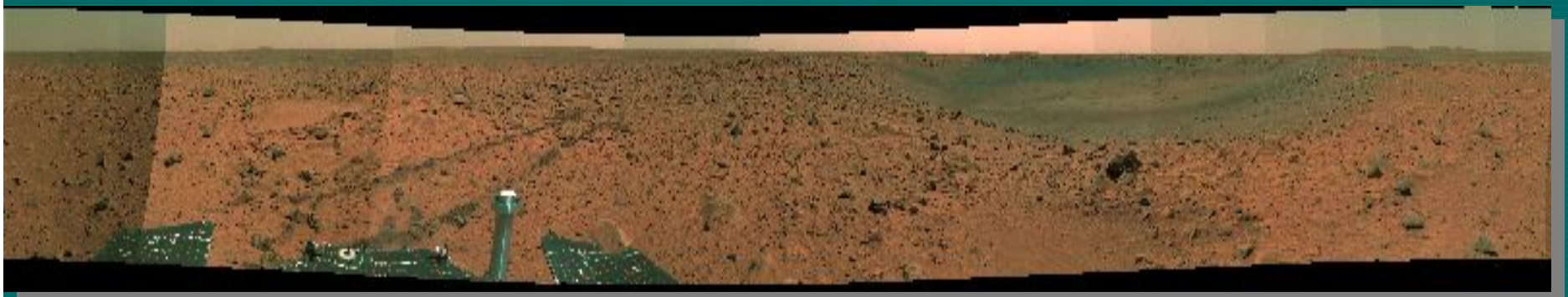
- No rocks detected in 7 images

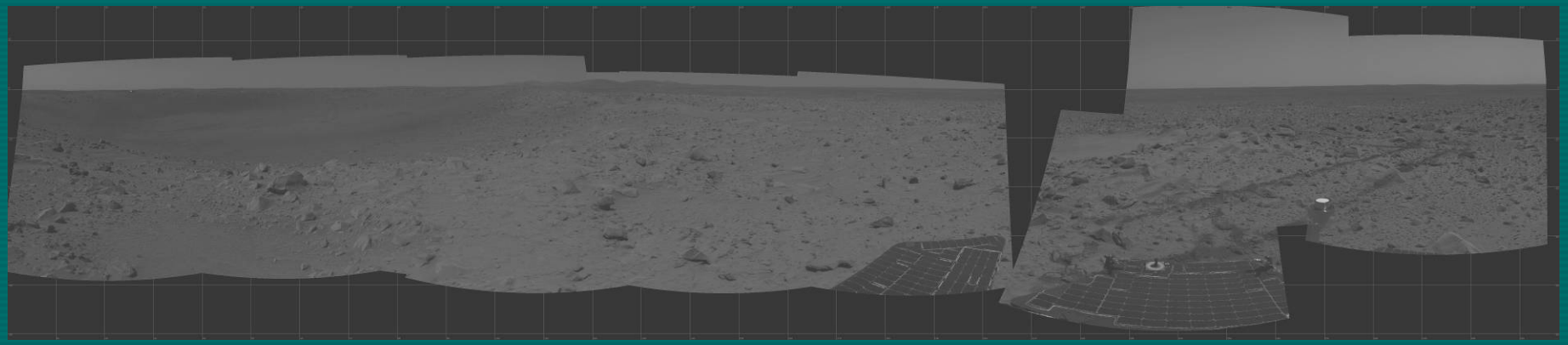
Examples



Bonneville Panoramas

Pancam panorama





Navcam panorama

Bonneville Pancam images collected on sol 68, March 12, 2004

Bonneville Results Summary

Automated Target Selection Results
(up to 5 targets per image were selected)

- PanCam (77 images)
  - 379 targets identified
    - 322 correctly are rocks
    - 42 rover parts
    - 11 near misses
    - 4 disturbed soil
- NavCam (9 images)
  - 35 targets identified
    - 32 correctly are rocks
    - 2 rover parts
    - 1 near miss
- HazCam (3 images)
  - 6 targets identified
    - 4 correctly are rocks
    - 2 rover parts

Automated target selection accuracy
(rock vs not rock)

	All targets identified	With rover hits removed
Pancam	85%	95%
Navcam	91%	97%

Science goal: 80% accuracy

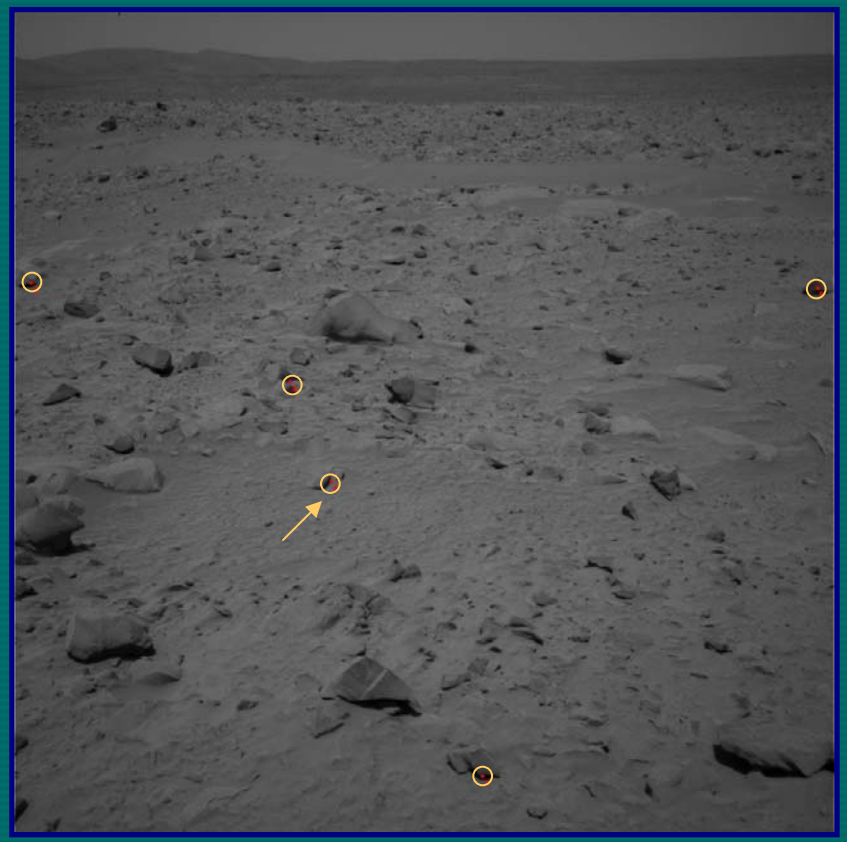
Bonneville Site - Pancam

Five automatically selected targets for three Pancam images

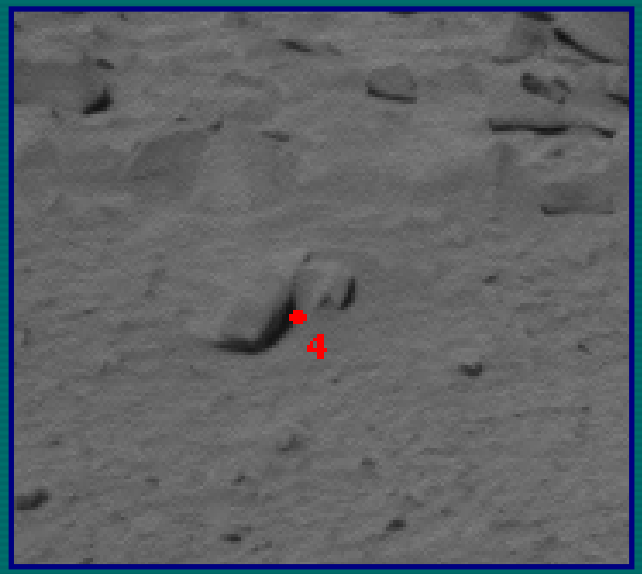
Note that a distance from camera cutoff was not used

Bonneville Site - Navcam

Five automatically selected targets for a Navcam image



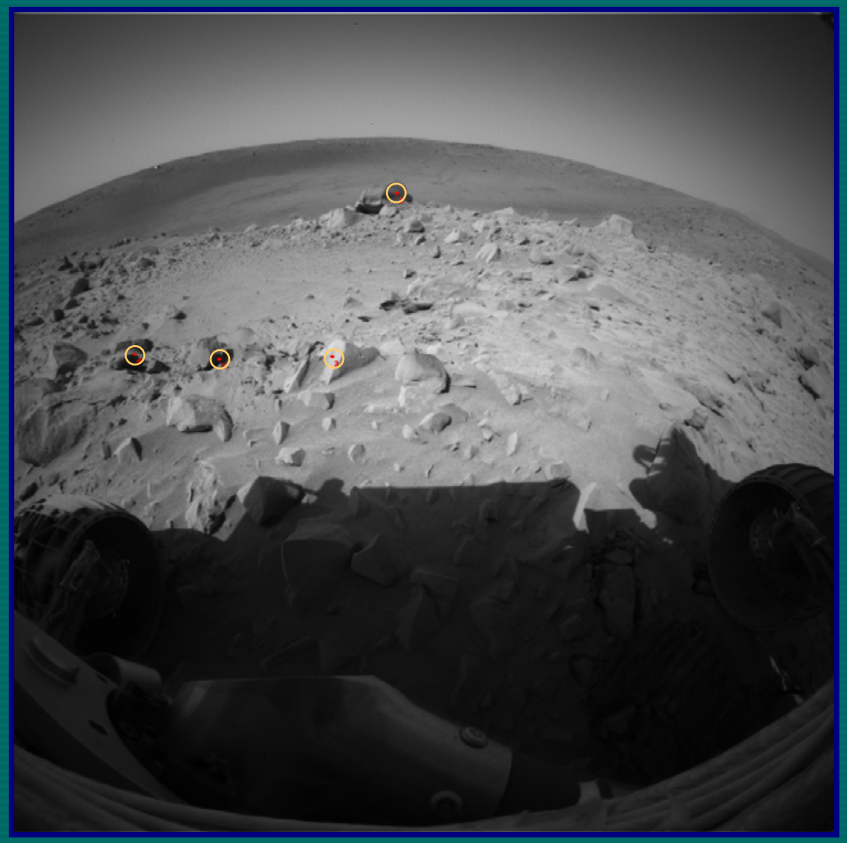
One target misses the rock

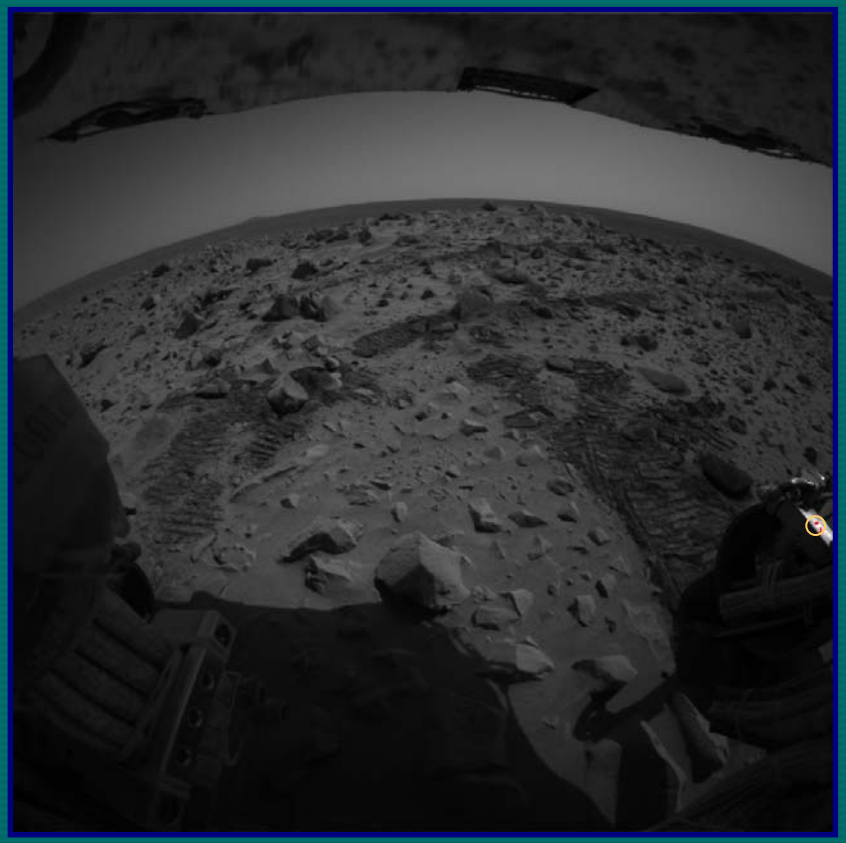


Bonneville Site - Navcam

Five automatically selected targets for a Navcam image

Bonneville Site - Hazcam





- Further evaluation and testing on Hazcam data is necessary

Technical Approach

Locate Rocks Algorithm

Original image

↓

Image Preprocessing

↓

For each ROI:
Normalize and filter
Edge sharpening,
detection and tracing

↓

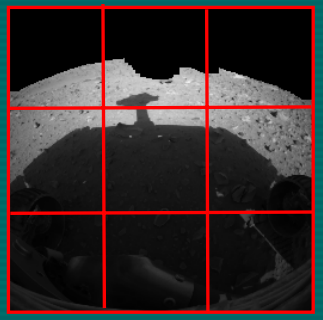
Combine blobs found in each ROI

↓

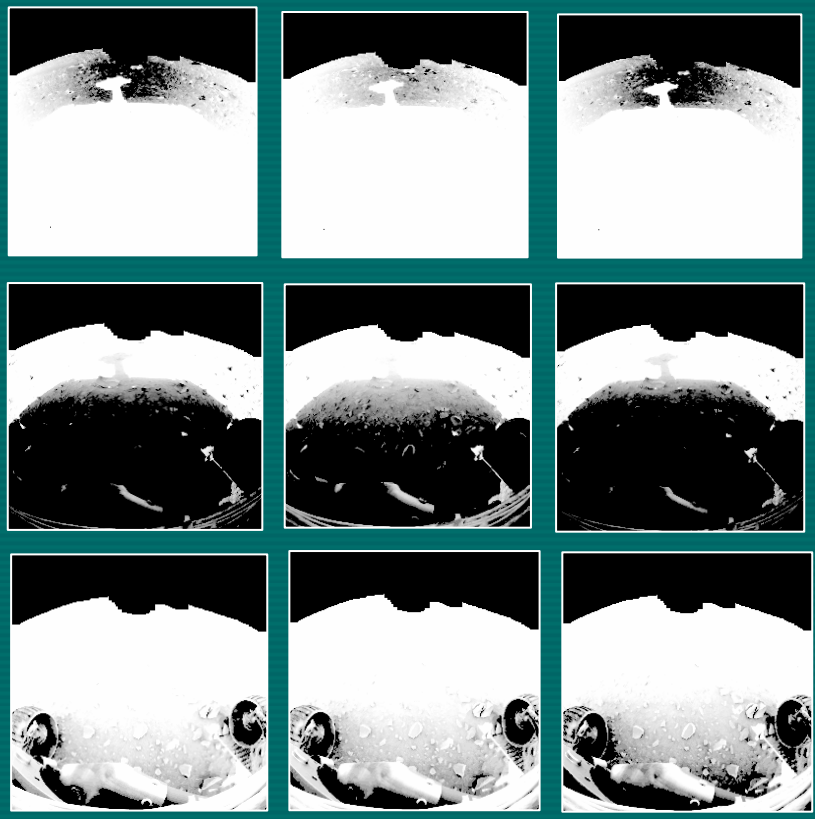
Prune blobs unlikely to be rocks

↓

List of rocks

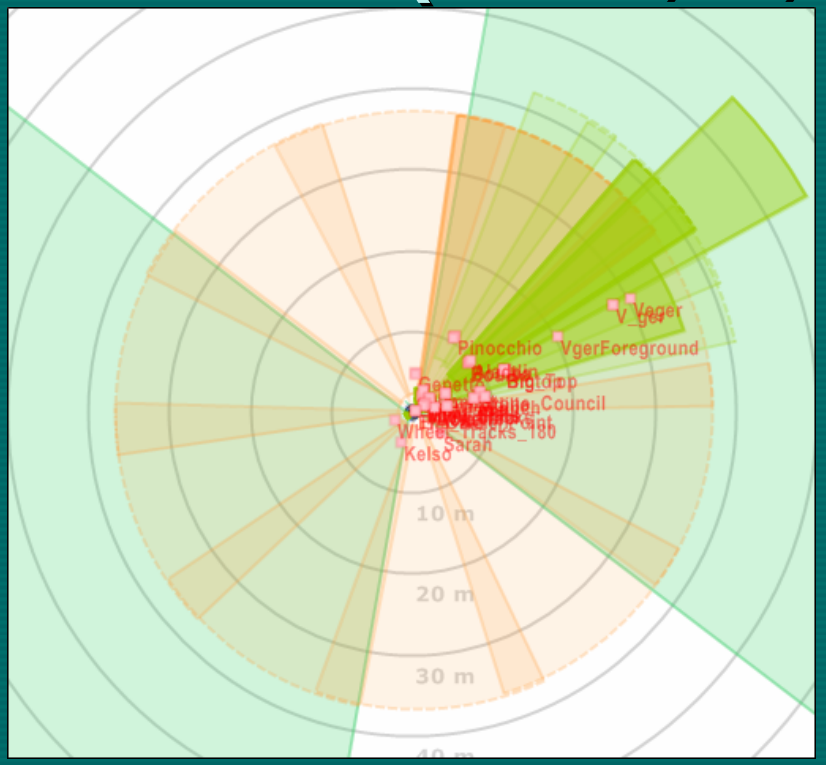


Normalization of 3x3-ROIs image

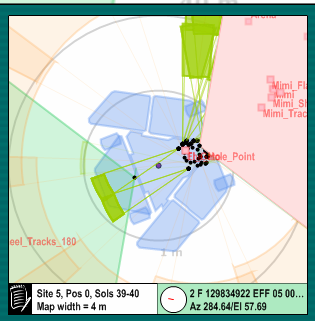


Site 5

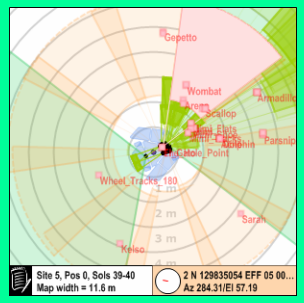
(Site 7,10,30 not shown)

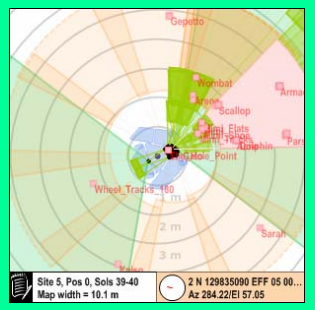


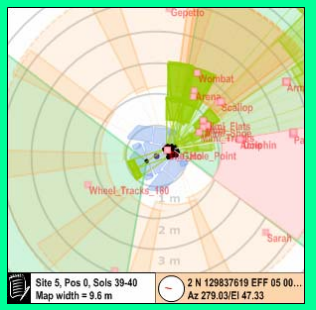
Haz

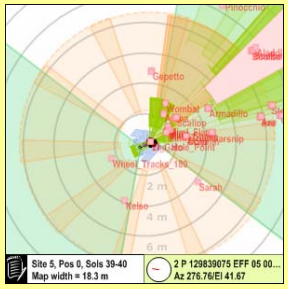


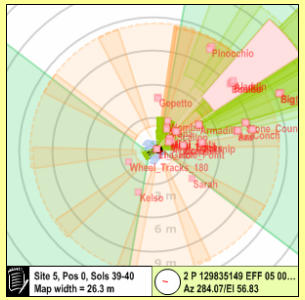
Nav

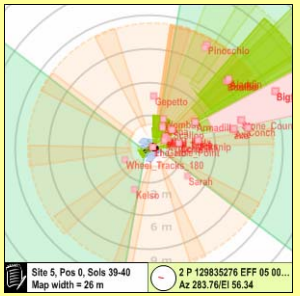


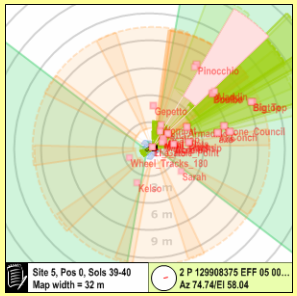


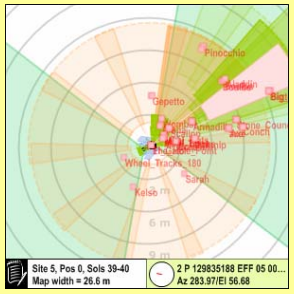








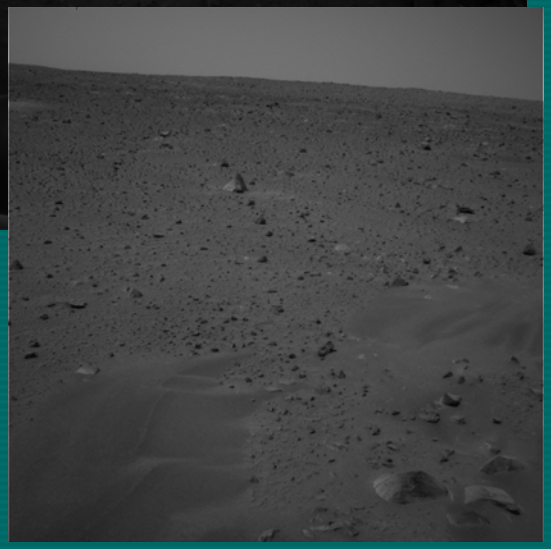


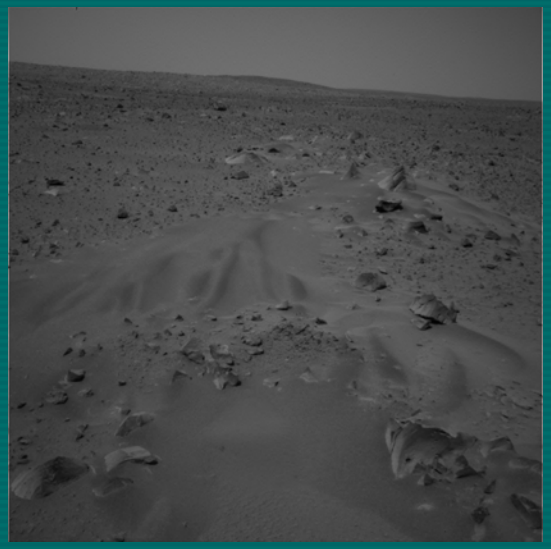


Pan

Site 5

Haz and Nav images

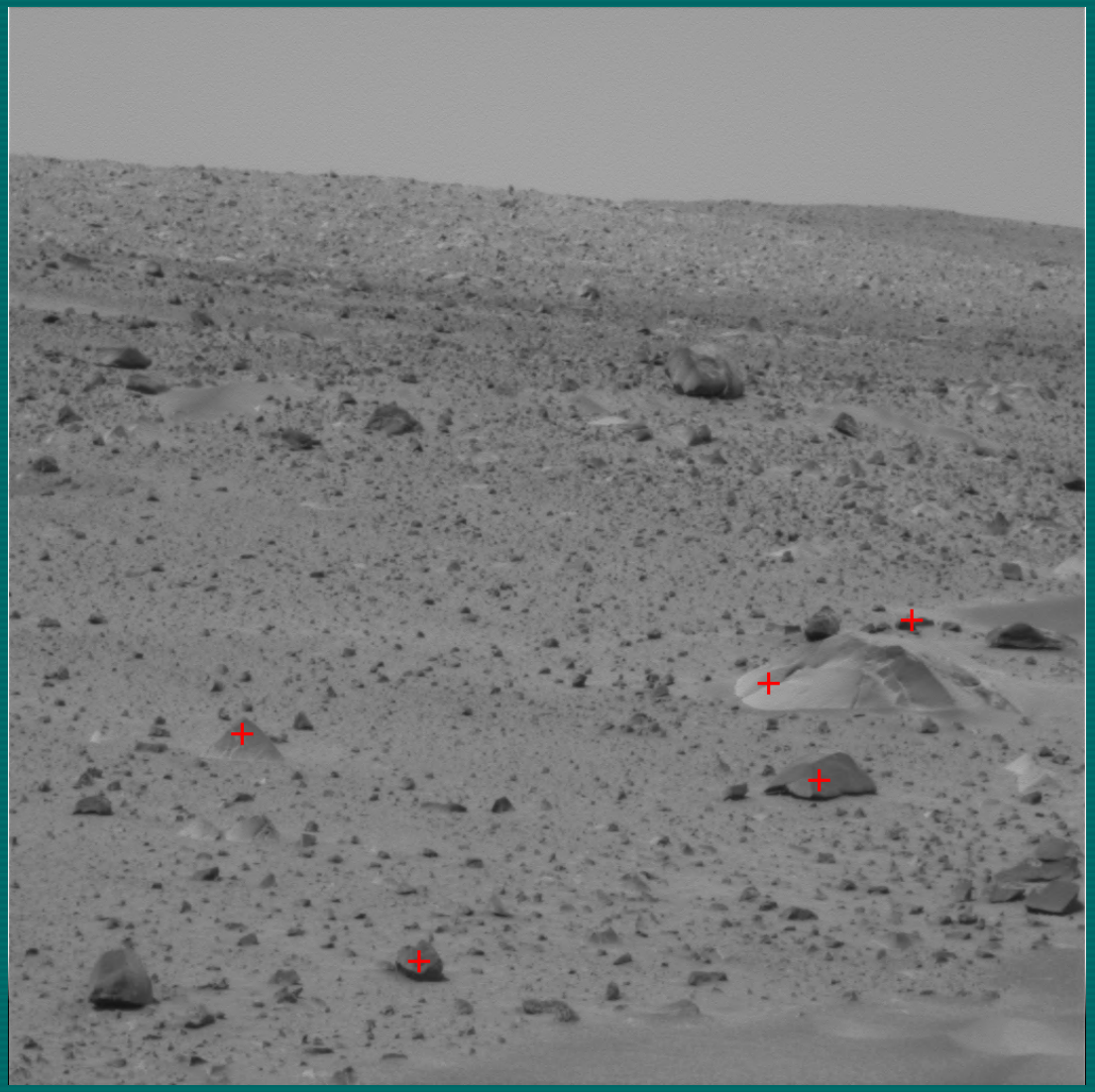




Accomplishments

- Accuracy
  - Pancam: 90% of prioritized targets are rocks.
  - Navcam: 70% of prioritized targets are rocks.
- Prioritization
  - Pancam: 73% of prioritized targets include largest rock in scene.
  - Navcam: 77% of prioritized targets include largest rock in scene.
- Speed
  - Reduced pyramid to one level
  - Use 256x256 image rather than full image
  - 2.2 GHz Pentium laptops:
    - 1x1 regions – 1.4 sec 2x2 regions – 4.0 sec
    - 3x3 regions – 12.0 sec 4x4 regions – 16.0 sec
  - We expect we can improve these numbers by a factor of 2.

Example Results

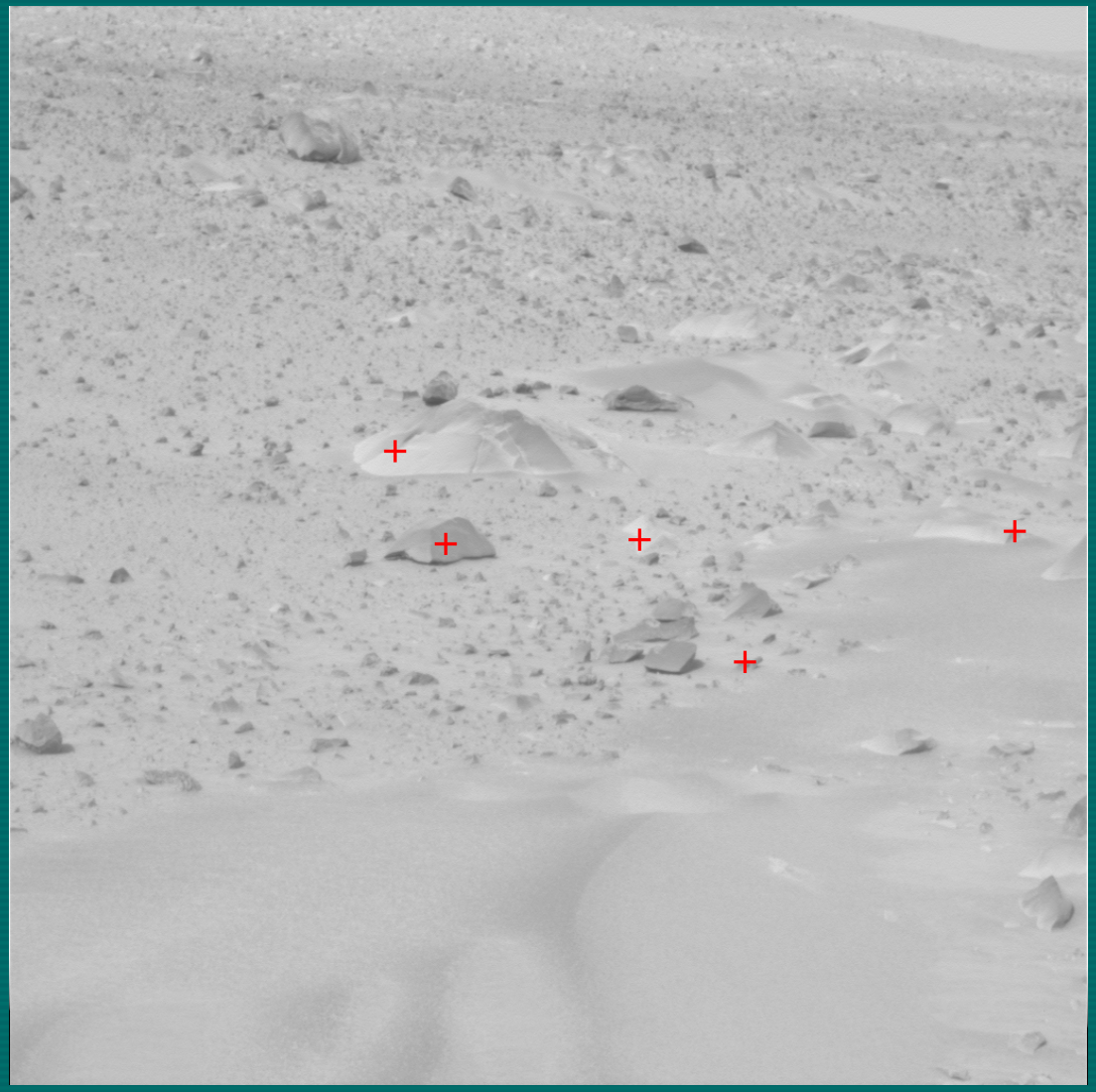


Site 5, Sol 39
Pan Image

5 targets selected. Top 3 are large rocks.

PDS ID: 2P129835188EFF0500P2396L2M1

Example Results

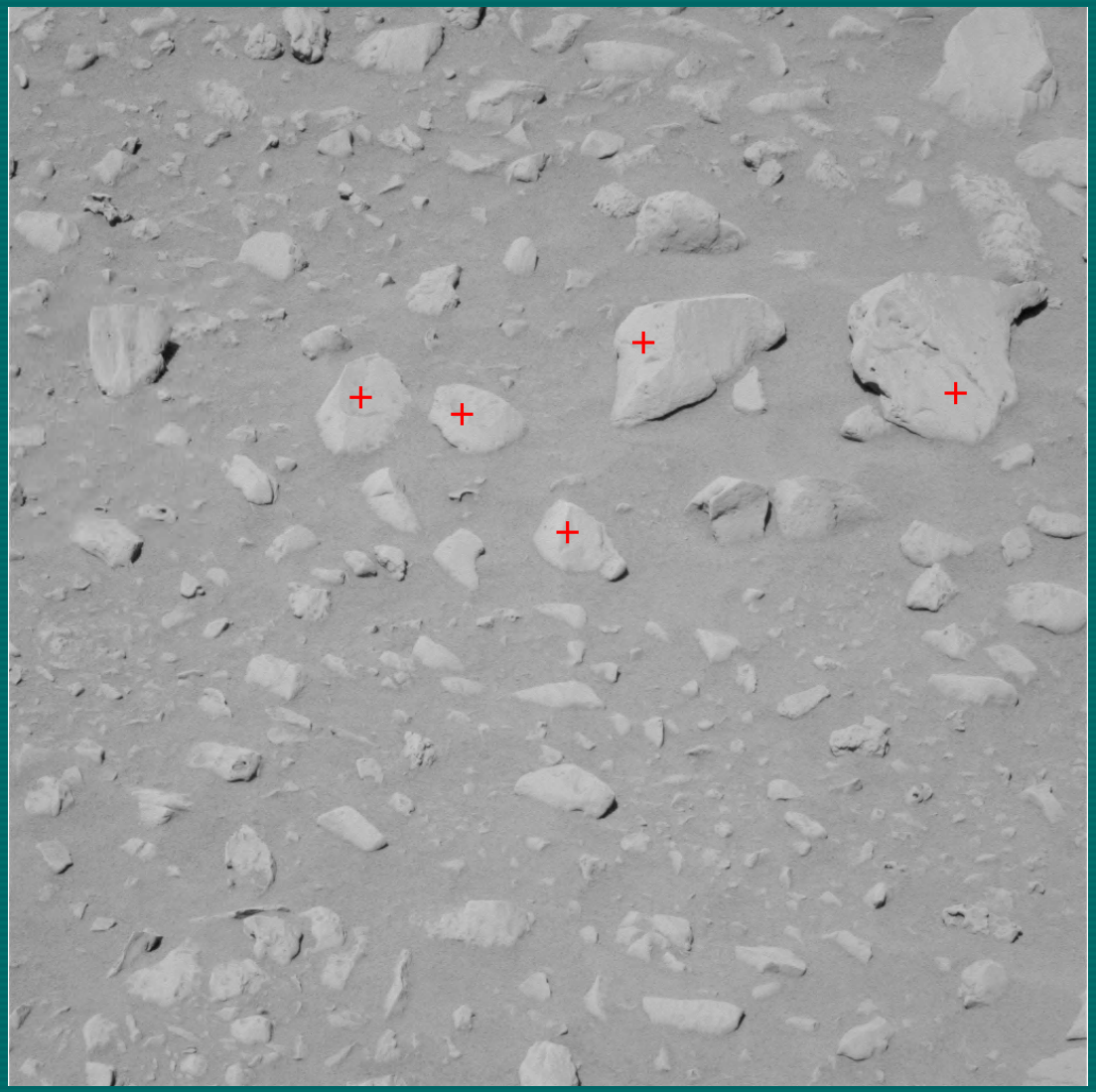


Site 5, Sol 39
Pan Image

4 targets selected. Near hit on fifth small rock.

PDS ID: 2P129839301EFF0500P2395L2M1

Example Results



Site 30, Sol 104
Pan Image

5 targets selected. All are large rocks.

PDS ID: 2P135596629EFF3000P2386L6M1